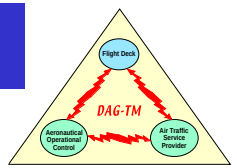
Concept Element 6

En route: Trajectory Negotiation for (a) User-Preferred Separation Assurance (b) User-Preferred Local TFM Conformance

Steve Green

NASA Ames Research Center

Distributed Air Ground Traffic Management (DAG-TM)
Industry Workshop
May 23, 2000



Outline

- Concept Element Overview
- Research Issues
- Technology Development
- Research Plan
- Additional Presentations

En Route (*&Transition*): Trajectory Negotiation

for User-preferred Separation and Local-TFM Conformance

Problem:

ATSP cannot accommodate trajectory change requests due to workload; and ATSP-issued clearances often cause excessive deviations for separation assurance or are otherwise not preferred by users

Solution:

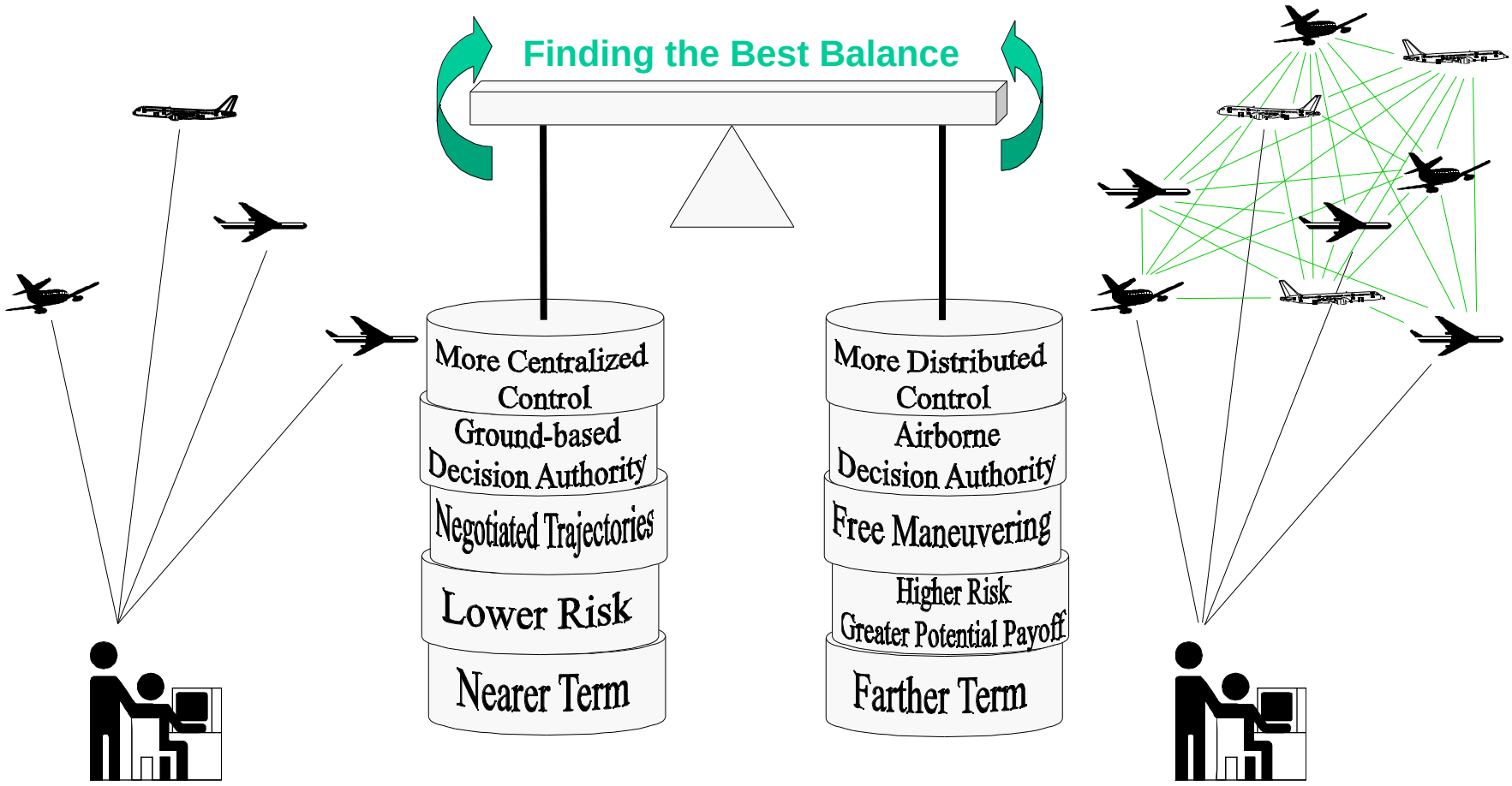
User and ATSP negotiate for user-preferred trajectory changes:

- **User formulates preferred trajectory changes, based on the latest Wx, SUA, and local TFM constraints (e.g., STA), and transmits it to the ATSP.**
- **ATSP evaluates trajectory change request for approval. If not approved, ATSP transmits additional constraints or issues an alternative trajectory.**

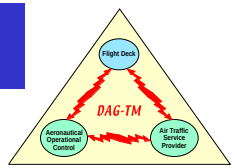
Potential Benefits:

- **Increased user flexibility / efficiency within the presence of conflicting traffic and dynamic en route constraints**
- **Shift in ATSP workload**
- **Reduced excess separation buffers**
- **Reduced voice communications**

"Complementary" Concept Elements



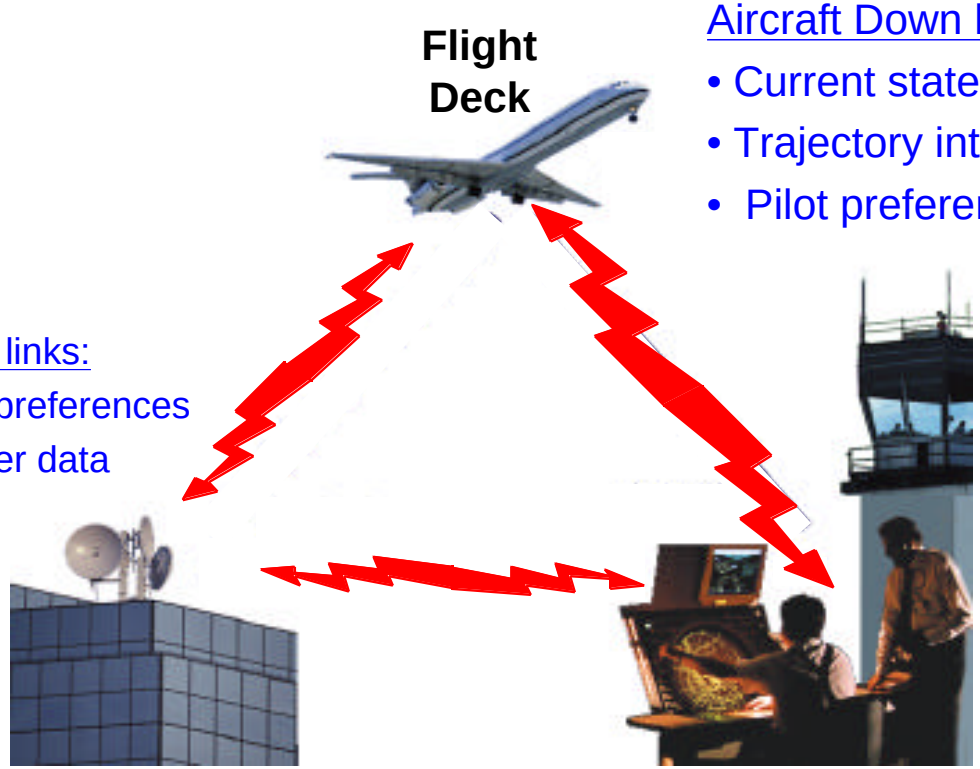
Pursuit of complimentary concept elements will lead to the best solutions in terms of feasibility, cost/benefit, and transition.



Summary of CE-6 Unique Features

- **Distributed information and flow conformance**
- **Responsibilities:**
  - **ATSP**
    - » **Separation of all traffic**
    - » **Flow conformance for all “unequipped” traffic**
  - **User**
    - » **4D conformance (equipped aircraft)**

Data Exchange



Aircraft Down links:
- Current state
- Trajectory intent
- Pilot preferences/constraints

AOC Up links:
- Airline preferences
- Key user data

ATSP Up links:
- Winds on path
- Trajectory constraints
- Relevant Flight & Traffic Information

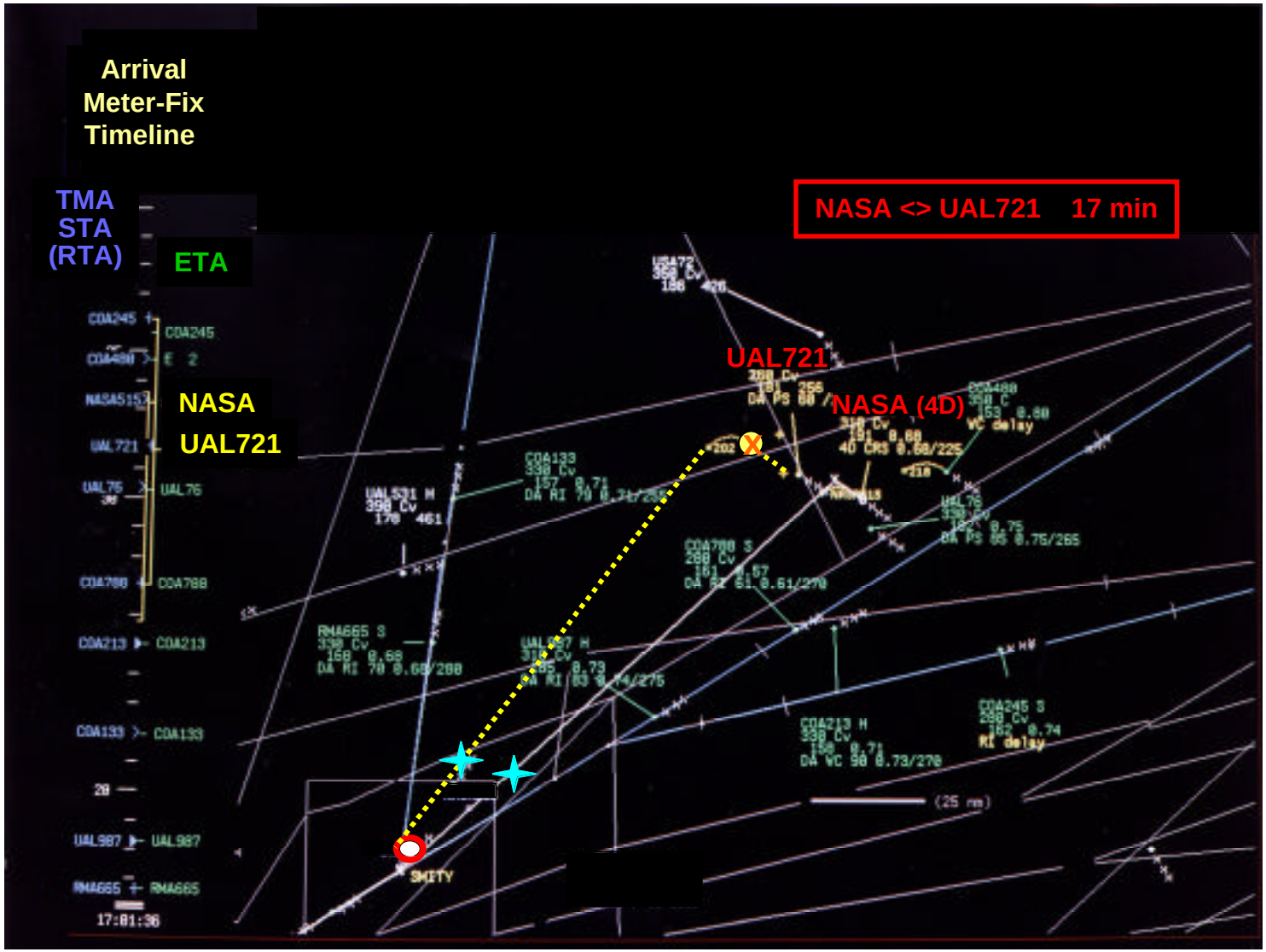
Airline Operational Control

Air Traffic Control

AOC Ground links:
- Airline preferences
- Key flight data

ATSP Ground links:
- Relevant NAS state information

Trajectory Negotiation



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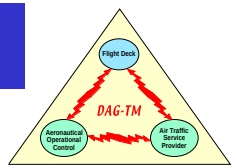
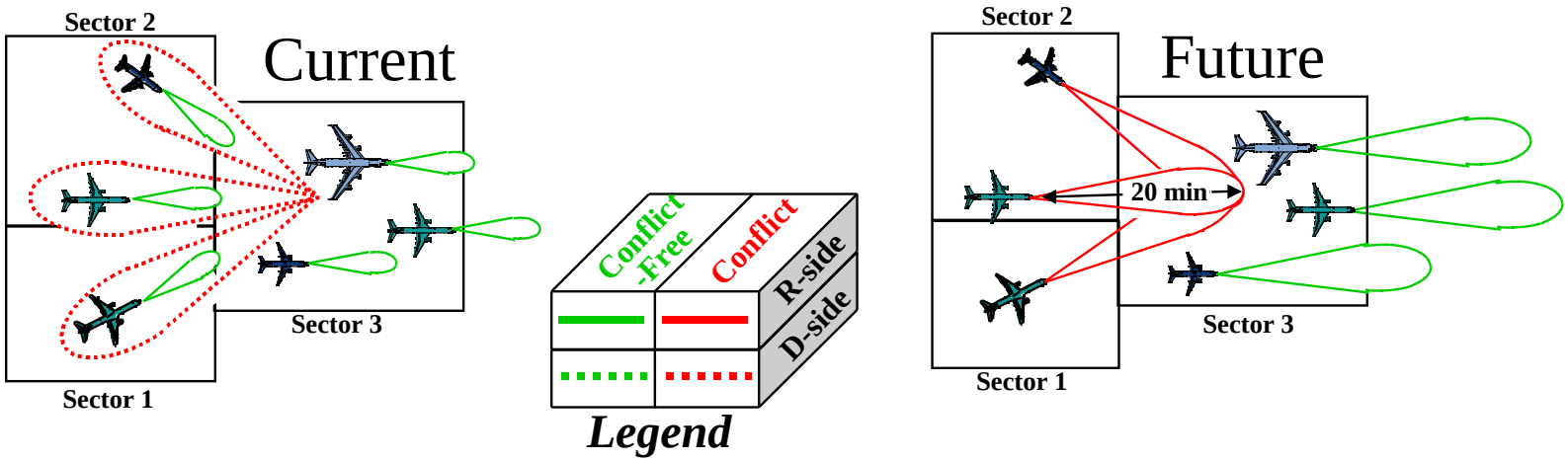


Research Issues

- **Trajectory Orientation (inter/intra-sector coordination)**
  - **ATSP roles, responsibilities, and procedures**
- **Trajectory Prediction Accuracy**
  - **Impact on ATSP DSTs**
    - » **Conflict Probe Performance (false-alarm and missed-alert rates)**
    - » **Flow-rate Conformance (uncertainty)**
  - **Error Sources**
    - » **Intent [path, speed, altitude profiles]**
    - » **Winds**
- **ATSP Decision Support Tool (DST) Capability**
  - **Flow-rate conformance**
  - **Integration of flow-rate conformance planning with CD&R**

Inter-sector Coordination

(New ATM Procedures)

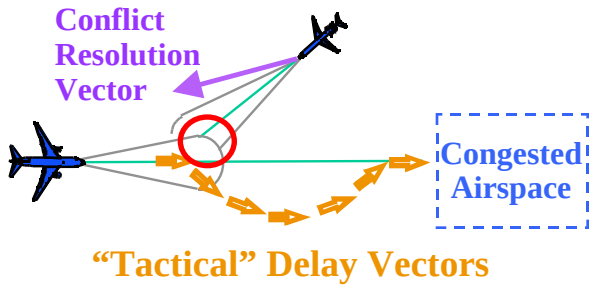


- **Current ATM**
  (Sector Oriented)
  - – R-side issues clearances
    - » Tactical in nature
  - – D-side looks upstream
    - » Strategic planning to adjust incoming traffic
  - → *Interruptions result*

- **Future ATM**
  (Trajectory Oriented)
  - – Strategic trajectory planning:
    - » Longer time horizon (more strategic)
    - » Accounts for downstream constraints
      - Conflicts
      - Merges
      - MIT / metering

ATSP DST Capabilities

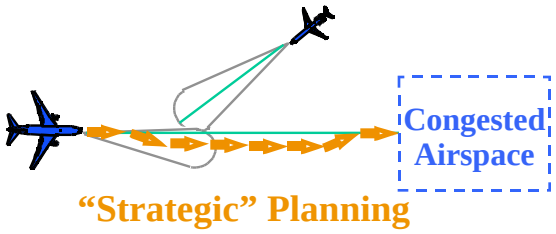
No flow-rate conformance tools



- Large vectors (more fuel/work)
- Conflict Probe lacks "delay intent"

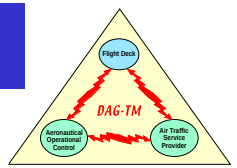
Today

Flow-rate conformance tools integrated with Conflict Probe



- Speed control (less fuel/work):
- One action solves conflict & delay

Future



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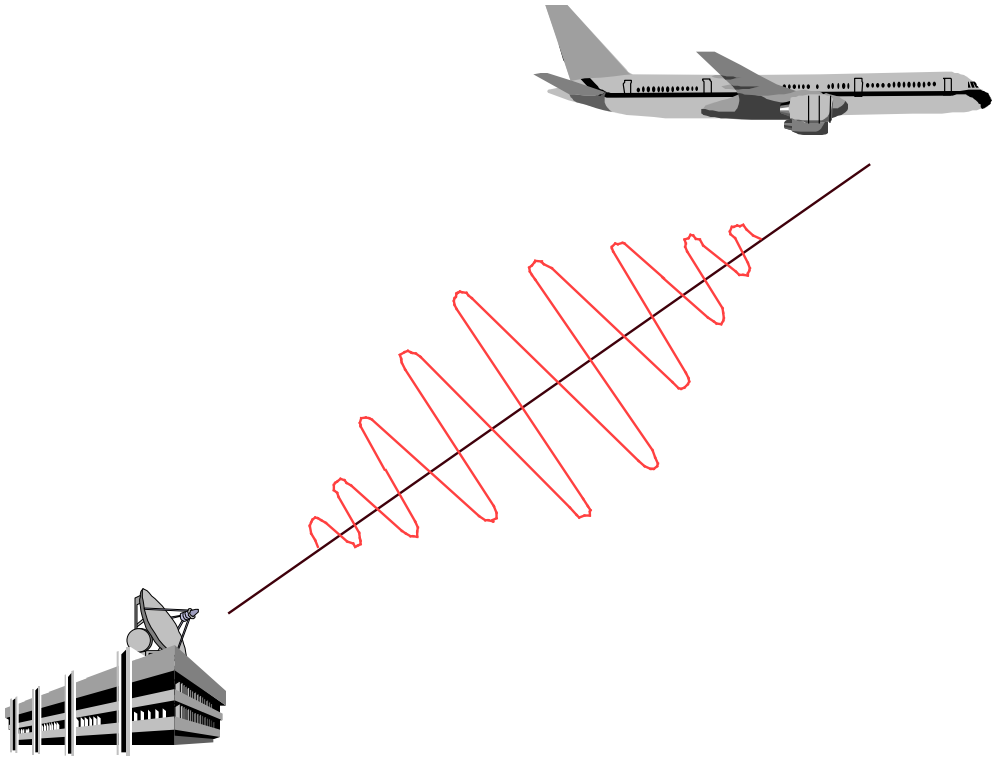
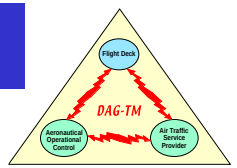
Technology Development



Flight Deck Automation

CTAS-based
ATSP DST Automation
(support sector operations)

En route Descent Advisor (EDA)



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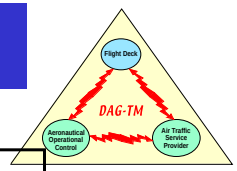
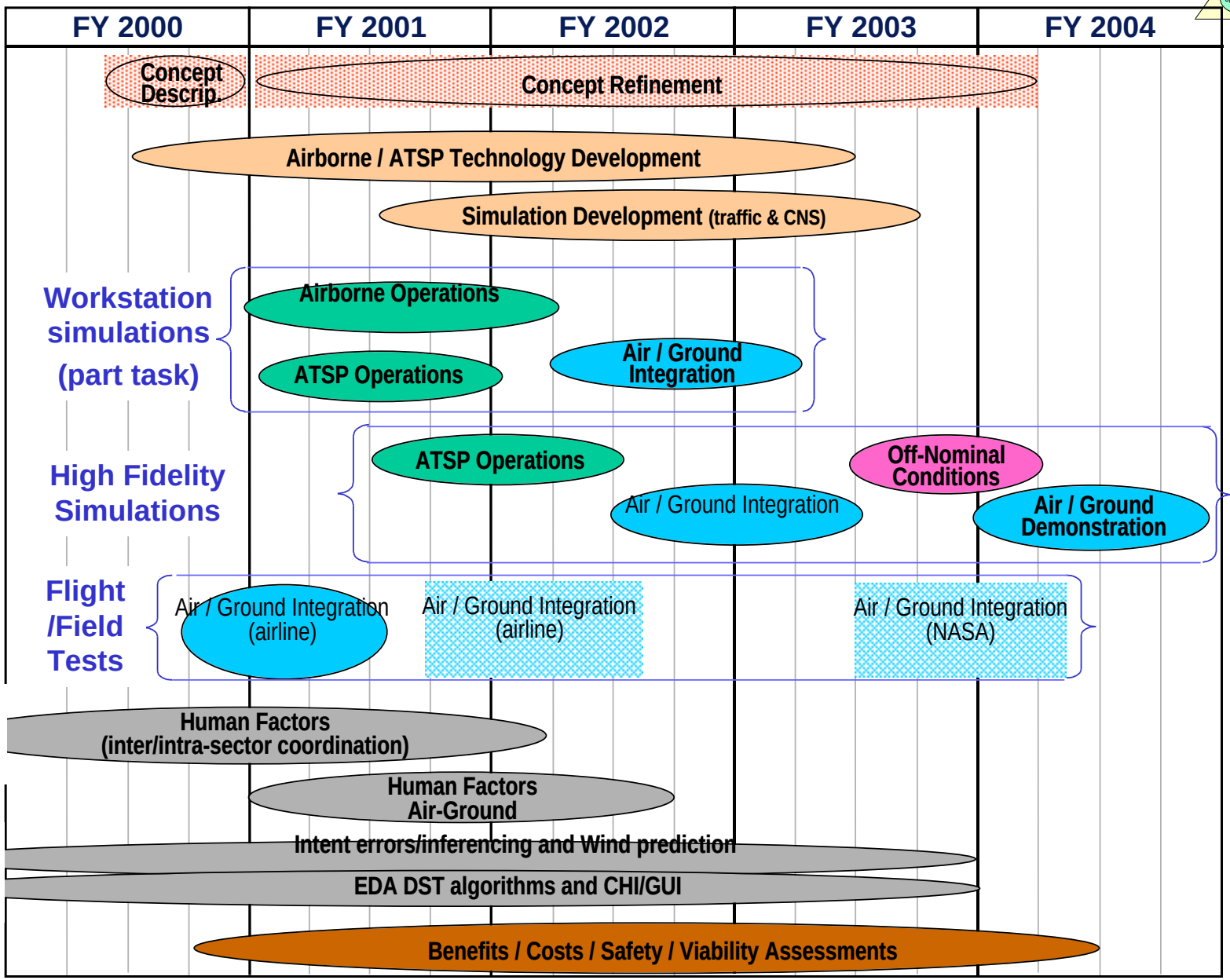
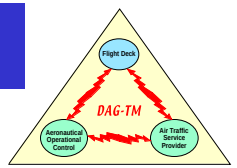
En route Trajectory Negotiation



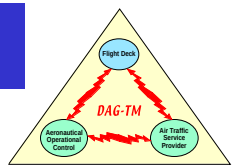




Research & Development Status

- **Initial concepts defined and explored for data exchange and trajectory negotiation**
  - **integration of 4-D ATSP advisories with 4-D FMS guidance and control**
  - **4-D trajectory negotiation between an FMS and ATSP automation**
  - **air/ground information exchange for calibrating and improving the accuracy of ATSP and FMS trajectory predictions**

- **Studies on trajectory prediction and conformance**
  - **conformance accuracy of actual aircraft trajectories with ATSP predictions, for both FMS and non-FMS equipped aircraft**
  - **availability of pre-departure information from user systems for use in improving ATSP trajectory predictions**
  - **current wind prediction accuracy and potential ATM DST performance improvements through downlink of aircraft wind measurements**



Session Presentations

- **Kenneth Leiden, Micro Analysis & Design**

  “Trajectory Orientation”

- **Gene Wilhelm, MITRE/CAASD**

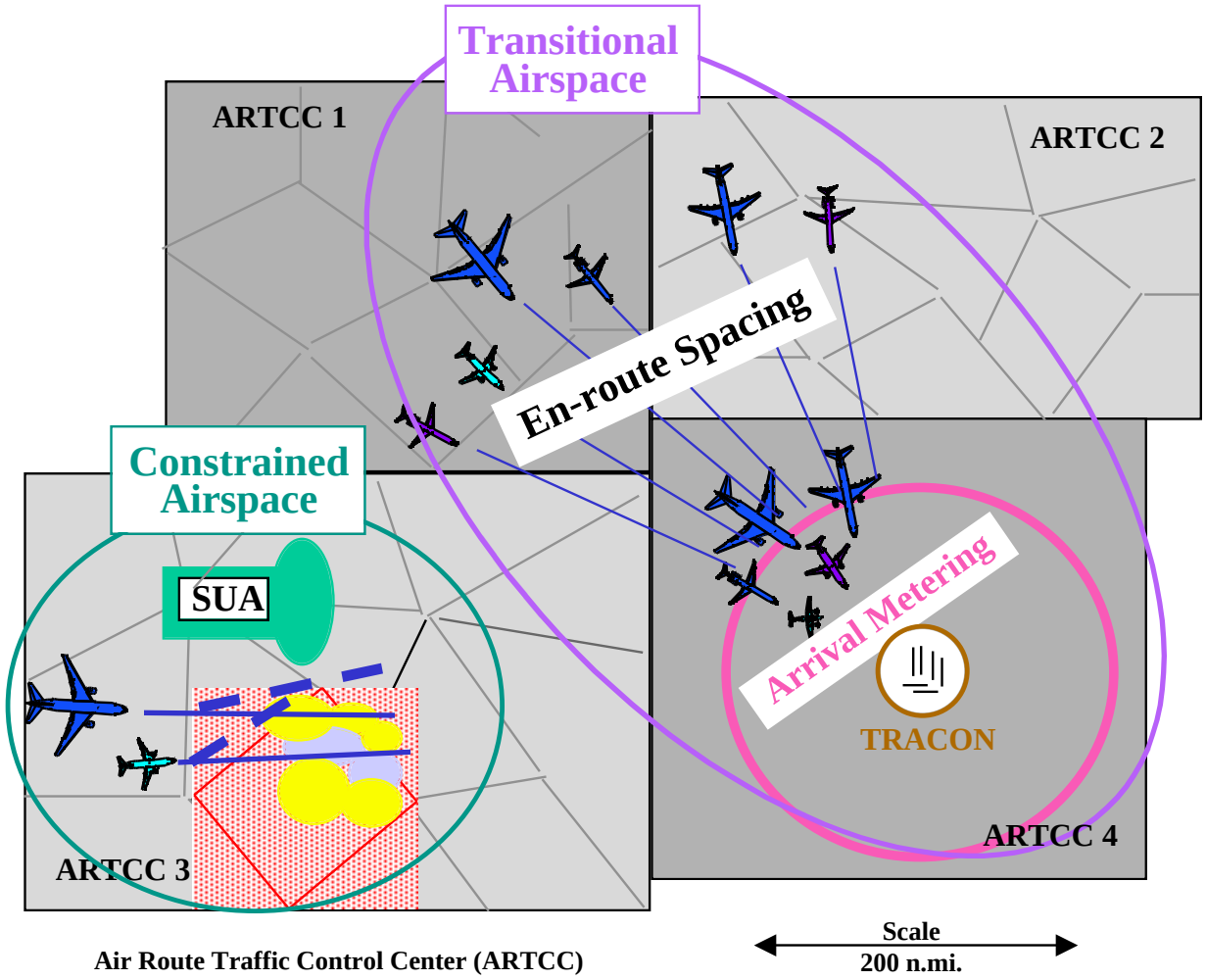
  “Problem Resolution Support for the En route Sector Team”

- **Rich Coppenbarger, NASA**

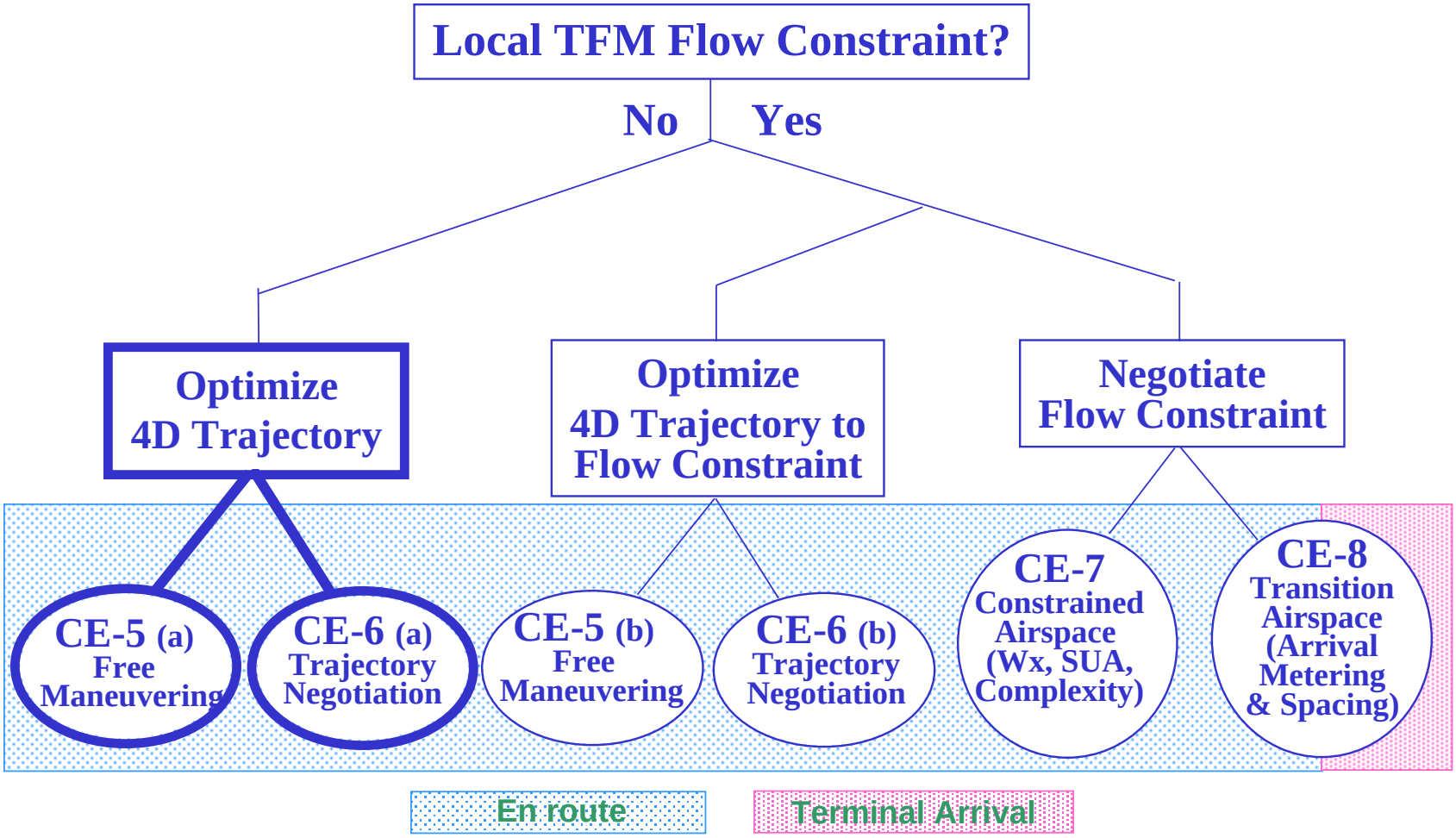
  “Trajectory Negotiation and En route Data Exchange”

Transitional and Constrained En route Airspace

Integration of Flow-rate Conformance and Separation Assurance

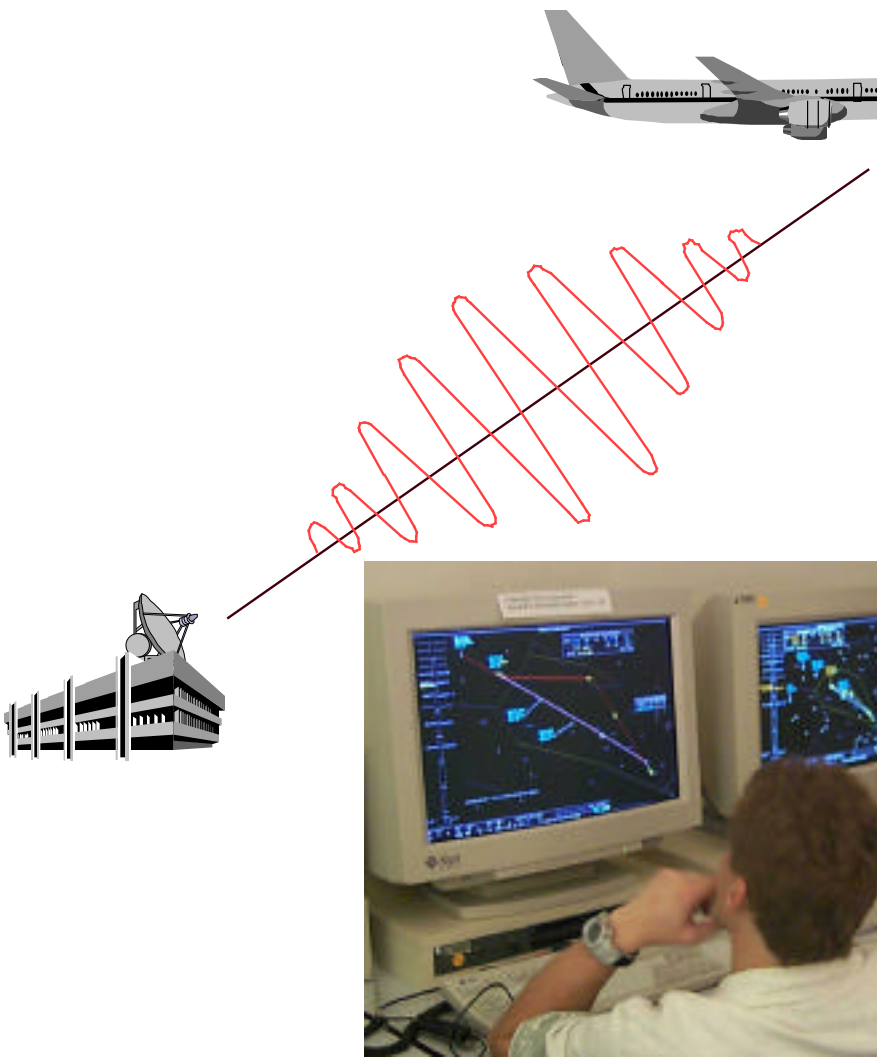


Mapping of En route Concept Elements 5-8



TFM = Traffic Flow Management

Technology Development



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